MCASA
Maryland Coalition Against Sexual Assault

Neurobiology of Trauma

FACT SHEET

Key Terms

Amygdala: The region of the brain that is responsible for emotional processing, integrating memory and emotion, and the autonomic responses associated with fear.

Hippocampus: The region of the brain responsible for processing sensory information into memory. This region is very sensitive to hormone fluctuations which can significantly affect functioning and processing.

Hypothalamus: The brain region that regulates hormones, initiates the stress response of the HPA axis, and maintains homeostasis.

Hypothalamic-Pituitary-Adrenal (HPA) Axis: Consisting of the hypothalamus, pituitary gland, and adrenal glands, the HPA axis controls the body's stress response through the release of hormones and chemicals including cortisol and adrenaline, to respond to external stress. The HPA axis also rebalances the body after experiencing stress.

The Brain in Survival Mode

The human brain is wired to ensure our safety and survival. During a traumatic and life-threatening experience, the brain quickly initiates an unconscious and evolutionarily based stress response that increases one's likelihood of survival. This complicated stress response, often simply referred to as "fight, flight, or freeze," includes an influx of hormones that affects one's attention, memory processing and consolidation, rational thought processes, and more. This stress response, and its effects on brain and bodily functions, are outlined below.

Initial Response

Before the brain begins to activate the stress response responsible for increasing survival during a life threatening and traumatic event, the amygdala must first detect an external threat to one's safety. Upon detection of a threat to one's safety and survival, the amygdala is responsible or activating the hypothalamus, the first structure in the HPA Axis. Once activated by the hypothalamus, the HPA Axis floods the body with natural hormones and chemicals that are designed to enhance survival. [i,ii]

Hormones and Memory

This flood of chemicals, which includes hormones such as cortisol and adrenaline, are focused on the body's physical response to threats. As a result, other brain and bodily functions, such as rational thought, attention to detail, affect, memory processing and consolidation, can be impaired. In fact, the flood of hormones significantly effects the hippocampus and its ability to process and store information. As a result, many survivors of sexual assault experience difficulties retrieving memories of the assault and find that the information that can be recalled is fragmented, incomplete, or out of sequence. [iii] However, this impairment does not mean that the available memories are inaccurate, nor does it mean that a sexual assault cannot be accurately recounted.

The effect of hormones on the hippocampus will vary between assaults and individuals and memories that are recalled should be valued and considered by investigators. In general, the encoding of contextual information, such as time, place, and sequence of events, is disrupted. However, sensory details such as smells, sounds, and sights, are often encoded successfully.[iv] These details may be essential to investigations and proper interviewing techniques can assist in the further recollection of contextual

information. However, it is important to recognize that drugs and alcohol may further hinder the encoding process. [v,vi]

Fight, Flight, or Freeze

The idea of a fight-or-flight response to threats is well-known and often perceived as the only means of increasing survival during a traumatic experience. However, there is a third survival response that many survivors of sexual assault experience known as ***freeze***. Although a freeze response may seem counterproductive, this response is a biological survival mechanism utilized by species throughout the animal kingdom. The initial freeze response is simply the fight or flight response on hold. It is during this initial freeze that the brain rapidly assesses the situation and implements a survival mechanism. In some cases, an individual may fight or flee, however, a continued freeze response can occur.[vii]

Two Types of Immobility

There are two types of the freeze responses, tonic immobility and collapsed immobility. Both types of immobility occur as a response to an inescapable threat, or strategy of last resort. Tonic immobility is characterized by muscle tension and paralysis, unresponsiveness to external stimuli, and is occasionally described as feeling cold or numb. The onset and termination of tonic immobility occurs rapidly, and episodes may last for seconds or hours.[viii] In contrast, collapsed immobility is characterized by loss of muscles tone and compromised, or loss of, consciousness. This type of immobility often has a slower onset and recovery period compared to tonic immobility.[ix]

Recovery

After a traumatic event like sexual assault, the brain, specifically the HPA Axis, will remain overactive for approximately 96 hours. As a result, a survivor may experience behavioral, emotional, and cognitive symptoms for several days. These symptoms often include increased levels of irritability, mood swings, flat affect, and impaired concentration.[x]

Sleep plays a significant role in one's return to homeostasis, the body's optimal level of functioning, by regulating the HPA Axis and restoring hormone levels.[xi] Additionally, sleep is directly correlated to the processing and consolidation of memories, meaning that a survivor may be better able to recall details of an assault after 1-2 full sleep cycles.[xii] These short-term effects on the brain and body, and the benefits of sleep, should be considered during law enforcement investigations and in order to ensure a survivor's well-being.

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[iv] Wilson, C., Lonsway, K. A., Archambault, J. (2020). Understanding the Neurobiology of Trauma and Implications for Interviewing Victims. End Violence Against Women International.
[v] Hagsand, A V., Roos af Hjelmsäter, E., Granhag, P.A., Fahlke C., Söderpalm Gordh, A., (2017)."Witnesses stumbling down memory lane: The effects of alcohol intoxication, retention interval, and repeated interviewing." Memory. 23(4), 531-543. 2017.
[vi] Harvey, A.J., Kneller, W., Campbell, A.C., (2013). "The effects of alcohol intoxication on attention and memory for visual scenes." Memory, 21(8), 969-980.
[vii] Kozlowska, supra note 1.
[viii] Wilson, supra note 6.
[ix] Kozlowska, supra note 1.
[x] Campbell, Rebecca. "Neurobiology Of Sexual Assault: Implications for law enforcement, prosecution, and victim advocacy". 2012. Presentation. https://nij.gov/multimedia/presenter/presentercampbell/Pages/welcome.aspx
[xi] Buckley, T. M. & Schatzberg, A. F. (2005). "On the interactions of the hypothalamic-pituitary-adrenal (HPA) axis and sleep: Normal HPA axis and circadian rhythm, exemplary sleep disorders." The Journal of Clinical Endocrinology & Metabolism. 90(5) 3106-3114.
[xii] Walker, M. P., (2009). "The role of sleep in cognition and emotion." The Year in Cognitive Neuroscience. 1156(1), 168-197.